Remarks / Arguments

1. With respect to claims 1-4, 6-7, 9-12 and 14

First of all, applicant wishes to clarify that in the previous arguments, applicant has never stated that the laser slab in '061 does not have any planar outer surfaces but only curved surfaces. The applicant admits that surface 34 in '061 are planar, however surfaces 34 are only the entrance surface for pump light (please refer to column 3, line 61 of '061) like the corner surfaces 32 in present invention, and these entrance surfaces do not take part in the pump light reflections inside the laser slab. In the previous arguments, what the applicants try to point out and emphasize is the difference between the cylindrical surfaces 18 being **inner reflective surfaces** other than outer surfaces 34 of '061 and the planar lateral surfaces 31 being **inner reflective surfaces** of present invention.

It is well known to one of ordinary skill in the art that surfaces that reflect pump light inside the slab are called as **inner reflective surfaces**. Further, it is obvious for one of ordinary skill in the art that the surfaces 34 in '061 are not inner reflective surfaces but entrance surfaces and can not be equivalent to the planar lateral surfaces 31 being inner reflective surfaces of present invention. Thus, applicant holds that it is a mistake conflicting with common sense for comparing the surface 34 not being inner reflective surfaces in '061 with the planar lateral surfaces 31 being inner reflective surfaces of present invention.

The inner reflective surfaces in '061 and present inventions achieve different effects on pump absorption respectively, and consequently serve different roles in '061 and present invention.

In particular, there are several major differences between '061 and present invention, which are listed below for clarity.

(1) '061 discloses a special pumping scheme using edge-pumping or side-pumping (please see column 3, lines 22-24 of '061). The key technical feature of '061 is the cylindrical surfaces 18 on the top and bottom cladding layers 46, 48 of the undoped cladding layer 14 (please see column 3, lines 32-33, and claims 1 and 13 of '061). The cylindrical surfaces 18 are preferably designed with a concave hyperboloid or near-hyperboloid shape. It is just this cylindrical surface 18 that makes '061 different from normal edge-pumping or side-pumping scheme. Here **the cylindrical surfaces 18** are designed to reflect and confine pump light in the laser slab (please see Fig.1 of

'061), and thus **<u>are the inner reflective surfaces</u>**. These cylindrical surfaces 18 form a concentrator to concentrate the pump light in the slab center (please see Fig, 1 and 3 of '061). With the concave hyperboloid or near-hyperboloid shape, the cylindrical surfaces 18 can reflect pump light with decreased incident angle, and at slab center, the incident angle will be near zero, therefore theoretically, pump light from one side of the laser slab can not pass through slab center and will be confined in the half slab of the same side. This technique allows pump light distributes more densely in slab center than in slab side and be largely absorbed by doped central portion of laser slab (because of the decreasing pump incident angle). While on the other hand, to lower pump transmission loss and increase absorption efficiency, cylindrical surfaces 18 must be coated to ensure high reflectivity at the pump wavelength. One skilled in the art can see that at the slab center, pump light is nearly perpendicular to the cylindrical surface 18 (i.e. incident angle be near zero), therefore, without help of high reflectivity coating, pump light will experience very high transmission loss and therefore results in very low pump absorption efficiency. Furthermore, because one side pumping can only pump "one side", or saying "half slab", both-side pumping must be employed in the technical solution of '061'.

While in present invention, the laser slab 22 is cut at the corners of the undoped circumambient portion 34 of the laser slab 22to form small corner surfaces, thus the undoped circumambient portion of the laser slab comprises a plurality of corner surfaces 32 and a plurality of lateral surfaces 31. **<u>The lateral surfaces 31</u>** serve to reflect pump light inside the slab and thus **<u>are used as inner reflective surfaces</u>**. **<u>All the lateral surfaces 31 in present invention are PLANAR, compared to cylindrical surfaces 18 in '061</u>**. Pump light is guided into slab corner surfaces 32 and travels inside the slab. Because all the inner reflective surfaces (i.e. the lateral surfaces 31) are planar, the incident angle of the pump light after reflecting at the inner reflective surface will maintain unchanged (guarantee that TIR condition is always satisfied), pump light is then confined inside the slab largely by total internal reflections (TIRs) at the planar inner reflective surfaces, and therefore high reflectivity coating is not essential in present invention. Unlike '061, that pump light from one side is restricted in the half slab region (please see Fig.1 and 3 of '061), the present invention allows pump light from each corner surface propagating throughout the whole doped region, which means in the "corner-pumped" slab laser of the present invention, the distribution of absorbed pump power is more uniform in the whole doped region, and pumping from all corners is not strictly required.

These differences between '061 and the present invention are further listed below in Table 1.

Table 1

	'061	Present invention
Shape of inner reflective surfaces	Being CYLINDRICAL, preferably concave hyperboloid or near-hyperboloid	Being PLANAR
Function of inner reflective surfaces	Forming a concentrator to concentrate the pump light in the slab center.	Reflecting pump light by TIRs to obtain uniform pump distribution.
Pump power distribution	Having pump light to distribute more densely in slab center than in slab side and is largely absorbed by doped central portion of laser slab (because of the decreasing pump incident angle).	Allowing pump light from each corner surface propagating throughout the whole doped region, the distribution of absorbed pump power being more uniform in the whole doped region.
High reflectivity coating	MANDATORY Since pump light having decreased incident angle, cylindrical surfaces 18 must be coated to ensure high reflectivity at the pump wavelength. Without help of high reflectivity coating, pump light will experience very high transmission loss and therefore results in very low pump absorption efficiency.	OPTIONAL Incident angle of the pump light maintain unchanged, pump light is confined inside the slab largely by total internal reflections (TIRs) at the PLANAR inner reflective surfaces, and therefore high reflectivity coating is not essential.
Both-side or four-corner pumping	MUST BE EMPLOYED	OPTIONAL

(2) ‘061 discloses another embodiment designed for low f/number pumping (see Fig. 3 in ‘061). In Fig. 3, at first glance, there are four pump surfaces accepting pump light, which seems similar with the corner-pumping method in present invention. In fact, the two approaches are different not only in the object of slab design but also in the technical effect achieved. The comparison between the embodiment shown by Fig.3 in ‘061 and present invention is provided as follows

(2a) **Comparison regarding the objects of ‘061 and present invention**

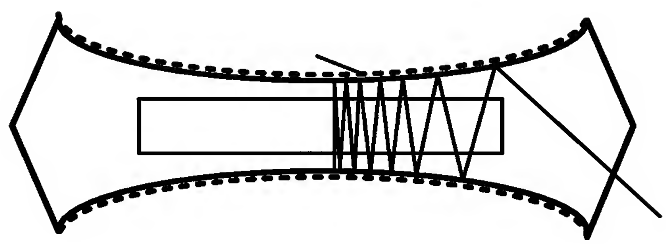
The object of the technical solution shown by Fig.3 of ‘061 is to achieve low f/number pumping, the precise angle of the entrance surface of the pump cavity 34 is selected according to the application and depends on a tradeoff between pumping efficiency and suppression of lateral parasitic lasing modes (please see column 4, lines 29-48 of ‘061).

While, the object of “corner-pumping” method of the present invention is to get high absorption efficiency while maintaining relatively high pump uniformity.

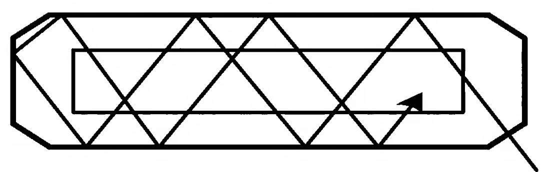
Therefore, the objects of ‘061 and present invention are obviously different with each other.

(2b) **Comparison regarding the technical solutions of ‘061 and present invention**

From following Fig. A, one skilled in the art can easily find out the difference between the technical solution of Fig.3 in ‘061 and that of present invention.



(i) Corresponding to Fig.3 in '061

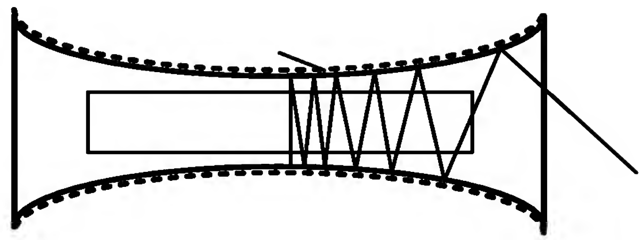


(ii) Corresponding to the present invention

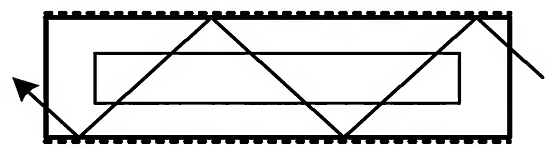
Fig. A (Comparison of '061 and present invention)

The applicants would like to emphasize the importance and necessity of cylindrical surfaces 18 (especially with concave hyperboloid or near-hyperboloid shape) to '061 again. In '061, **the surfaces 18 being inner reflective surfaces are cylindrical and can not be planar**, that is, if the cylindrical surfaces 18 being inner reflective surfaces are planar (see following Fig. B(ii)), pump light will pass through the whole doped region, and finally travels out of the slab, which will results in relatively high pump transmission loss.

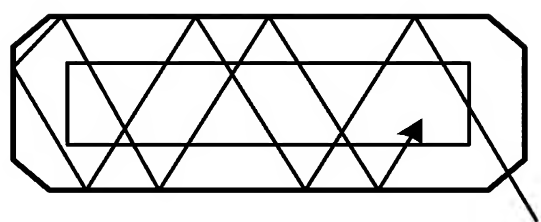
While in present invention, **all the plurality of the lateral surfaces 31 used as inner reflective surfaces are planar**, by benefiting from corner pumping technique, pump light is well confined inside laser slab largely by total internal reflections (TIRs), and will exhibits lower transmission loss, also the pump light distribution is more uniform than '061 (see following Fig. B(iii)).



(i) ‘061



(ii) ‘061 with planar inner reflective surfaces



(iii) Present invention

Fig. B Comparison of pump light path and distribution.

(2c) **Comparison regarding the technical effects of ‘061 and present invention**

The technical effect achieved by ‘061 (please refer to Fig.3 of ‘061) is “shapes and/or coat the entrance surfaces at the side edges of the pump cavity 34 to maximize transmission and avoid critical angle limitations” (please see column 4, lines 29-32 of ‘061). The “shaping” approach can only increase pump transmission at the entrance surfaces when compared to another embodiment shown by Fig.1 in ‘061.

While, the technical effects achieved by present invention are: (1) the pump light from each corner face propagate throughout the whole doped region, resulting that the distribution of absorbed pump power is more uniform in the whole doped region; (2) the pumping from all corners is not strictly required, and also high reflectivity coating is not mandatory.

With careful consideration of examiner's comments, to accurately reflect the protection scope of present invention, and clarify the most important difference between '061 and present invention (i.e. the shape of inner reflective surfaces of the laser slab), and have the examiner more easily understanding the same, the applicant amends the claims 1, 2, 6 and 9-10 of present invention as follows.

1. (Currently Amended) A corner-pumping method for high power slab laser comprising:

directing a pump light from one or more pump light sources each consisting of a high power diode array and its coupling system into a laser slab through prior cut slab corner faces of said laser slab without restriction to the incident angle or the polarization state of the pump light, wherein said laser slab includes an undoped circumambient portion and one or more doped central portions, **[and wherein outer surfaces of the slab are planar]** <u>**said undoped circumambient portion has said corner faces and a plurality of lateral surfaces used as inner reflective surfaces, and all the plurality of lateral surfaces are planar**</u>;

propagating said pump light within said laser slab, wherein said pump light firstly pass said undoped circumambient portion, secondly pass said doped central portion, thirdly pass said undoped circumambient portion again, and fourthly take inner reflection at the <u>**the plurality of lateral**</u> surface<u>s</u> of said undoped circumambient portion, and by repeating these steps, achieve multi-pass absorption; and

substantially absorbing the pump light <u>**by the said doped central portion**</u> during propagating.

2. (Currently Amended) The method as recited in claim 1, wherein corner faces of said **[laser slab]** <u>**undoped circumambient portion**</u> are coated for high transmission for the wavelength of the pump light, and <u>**the plurality of**</u> lateral **[faces]**<u>**surfaces**</u> of said **[slab]** <u>**undoped circumambient portion**</u> are coated for high reflection for the wavelength of the pump light.

5. (Canceled)

6. (Currently Amended) A corner-pumped laser gain module for high power slab laser comprising:

a laser slab including undoped circumambient portion **[,]** **and** one or more doped central portions **[and corner faces, and wherein outer surfaces of the slab are planar]** **said undoped circumambient portion having said corner faces and a plurality of lateral surfaces used as inner reflective surfaces, and all the plurality of lateral surfaces being planar**; and

one or more pump source providing a pump light, each pump source consisting of a high power diode array and its coupling system;

wherein said pump light from said one or more pump sources directly incident into said laser slab through prior cut slab corner faces of said **[laser slab]** **undoped circumambient portion** without restriction to the incident angle or the polarization state of the pump light, firstly pass said undoped circumambient portion, secondly pass said doped central portion, thirdly pass said undoped circumambient portion again, and fourthly take inner reflection at the **plurality of** lateral surface**s** of said undoped circumambient portion, and by repeating these steps, achieve multi-pass absorption, and substantially absorbed by the said doped central portion during propagation; and

wherein said laser slab outputs an amplified laser beam.

8. (Canceled)

9. (Currently Amended) The laser gain module as recited in claim 6, wherein a cross section of said doped central portion is rectangular**[,]or** square or circular.

10. (Currently Amended) The laser gain module as recited in claim 6, wherein said corner faces of said **[laser slab]** **undoped circumambient portion** are coated for high transmission for the wavelength of the pump light, and **the plurality of** lateral **[faces]surfaces** of said **[laser slab]** **undoped circumambient portion** are coated for high reflection for the wavelength of the pump light.

To sum up, the technical feature "**a plurality of lateral surfaces used as inner reflective surfaces, and all the plurality of lateral surfaces being planar**" in amended claims 1 and 6 of present invention are not disclosed or suggested by '061, Further, these technical features are not obvious at the time the invention was made to a person skilled in the art. Therefore, as compared with '061, amended independent claims 1 and 6 of present invention should possess novelty and inventiveness. Further, each of dependent claims also possesses novelty and inventiveness, at least by virtue of their dependency

2. With respect to claims 13

Firstly, regarding the Examiner holds that the applicant did not contest the rejection in the first two responses, applicant reminds the Examiner that in the first two responses to the office actions, applicant did provide an argument with respect to the rejection regarding claim 13, and thus requires the Examiner to carefully check the first two responses submitted by the applicant.

Applicants here provide the argument regarding the rejection to claims 13 again as follows:

In '997, two cylindrical lenses without lens duct are provided, and **the generatrices of these two cylindrical lenses are parallel, but not orthogonal**. The usage of these two cylindrical lenses is to form a one-dimensional spatial filter (please see column 25, lines 3-8 of '997) or a beam expander or reducer (please see column 25, lines 8-11 of '997) only in the slow-axis plane of the laser diode bar.

While in claim 13 of present invention, the coupling system includes two cylindrical lenses and a lens duct, **the generatrices of the two cylindrical lenses are orthogonal to each other and are parallel to fast axis and slow axis of the diode array, respectively**such that the pump beam can be collimated both in fast and slow axes of the diode array. After collimating, the lens duct is used to compress and direct the pump beam into corner surface of the laser slab.

Thus, the technical features "**said coupling system including two cylindrical lenses and a lens duct**" and "**generatrices of said two cylindrical lenses are orthogonal to each other and are parallel to fast axis and slow axis of said diode array, respectively**" in claim 13 of present invention are not disclosed or suggested by '997, and are not obvious at the time the invention

was made to a person skilled in the art. Therefore, claims 13 should possess novelty and inventiveness in view of '997.

CONCLUSION

Applicants have made an earnest and *bona fide* effort to clarify the issues before the Examiner and to place this case in condition for allowance. Reconsideration and allowance of all of the claims is believed to be in order, and a timely Notice of Allowance to this effect is respectfully requested.

The Commissioner is hereby authorized to charge any additional required fees from Deposit Account No. 502811, Deposit Account Name BROWN RAYSMAN MILLSTEIN FELDER & STEINER LLP.

Respectfully submitted,

Date: May 11, 2007

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